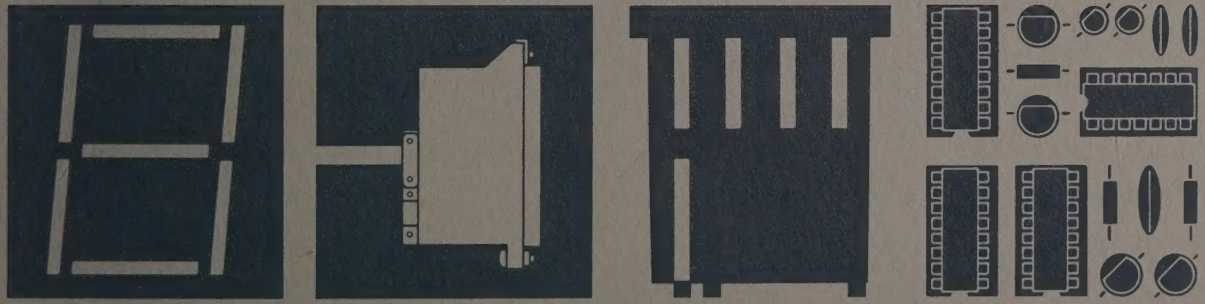
model 2780A digital panel meter

4½

METER ROOM



DigiTec Instrumentation

WARNING

This instrument is designed to prevent accidental shock to operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to do so can result in a serious or fatal accident.

SHOCK HAZARD (As defined in Underwriters Laboratories Radio and Television Receiving Appliances Standards for Safety, Twelfth Edition, dated June 25, 1969.)

"Shock hazard shall be considered to exist at any part involving a potential of between 42.4 volts peak and 40 kilovolts peak in the following cases:

A. If the current through a load of not less than 500 ohms exceeds 300 milliamperes after 0.0003 second.

B. If the current through a load of not less than 500 ohms exceeds 5 milliamperes after 0.2 second.

C. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.1 and 0.2 second, and the total quantity of electricity passed through the load up to that time exceeds 4 millicoulombs.

D. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.03 and 0.1 second, and the total quantity of electricity passed through the load up to that time exceeds $75T\text{-}350T^2$ millicoulombs, where T is the time in seconds.

E. If the potential is more than 5 kilovolts peak and if the total capacitance of the circuit is more than 3000 micromicrofarads.

NOTE: Additional factors might apply when potentials more than 40 kilovolts peak are present.

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SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

WARRANTY

UNITED SYSTEMS CORPORATION warranties that each instrument and other articles of equipment manufactured by USC to be free from defects in material and workmanship, when subjected to normal use and service. This warranty is expressly limited to the servicing and/or adjusting of USC supplied equipment (i. e. USC is not liable for damage to customer supplied equipment interfaced with USC equipment) returned, freight prepaid, to the factory or to the nearest factory authorized service center within one year from date of delivery; and to the repairing, replacing or adjusting of parts (excepting lamps, fuses, batteries, probes and electro-mechanical assemblies) which upon examination shall be found defective. This warranty shall not apply to any instrument or other article of equipment which has been repaired or altered outside of USC factory or authorized service stations nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation of use not in accord with instructions furnished by the manufacturer.

Material on electro-mechanical assemblies is warranted for 1 year from the date of delivery while labor is warranted for 90 days from the same date.

This warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and UNITED SYSTEMS CORPORATION neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products beyond the specifically provided hereinabove.

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Model 2780 A
DC Panel Meter

2780A

1. GENERAL INFORMATION

1.1 Unpacking and Shipping

After unpacking, carefully examine the instrument for physical damage that may have occurred in transit. If there is any indication of damage, file a complaint immediately with the carrier.

Save the shipping carton and packing materials for future storing or shipping of the instrument. If the instrument must be returned, contact United Systems Corporation for prior approval. When returning the instrument to the factory, give a full description of the reason and, if a malfunction is involved, the mode of operation of the instrument. When shipping the instrument, repackage in original carton or make certain that at least four inches of padding material surrounds the instrument to prevent damage during shipment. Upon receipt of approval, ship via UPS, motor truck, or air freight PREPAID to your nearest authorized service center. Countries outside the United States and its possessions should contact our local representatives for instructions.

CAUTION

The anti-static strip on the rear edge terminals MUST be retained and applied to the instrument before reshipping. If the alarm option board (option C) is shipped separately, the anti-static strip must first be installed on the edge terminals and the board must then be placed into a black anti-static bag before shipping.

If the anti-static strip has been misplaced, wrap the instrument or circuit board with aluminum foil before shipping.

1.2 Instrument Identification

The instrument models, serial number, and other pertinent data are given on the identification tag on the bottom of the instrument.

1.3 Features

The important features of this Panel Meter include:

Plug in IC sockets for easy serviceability
Large (.6″ high), long life LED Readout display
Four and a half digits of display
Extremely stable zero
Externally programmable decimal point position
Overrange voltage blinks to prevent misreading of data

1.4 Technical Characteristics

Model	Range	Accuracy*	Resolution	Input Z	Overload Protection (DC or AC Peak)
2780A-02	±1.9999V	±0.01% of	100μV	1000 meg	±200VDC
2780A-03	±19.999V	reading ±	1mV		
2780A-04	±199.99V	0.005% of	10mV		
2780A-05	±1000.0V	Range	100mV	10 meg	±1.2KV
				Shunt	
2780A-08	±199.99μA	±0.05% of	0.01μA	10K	
2780A-09	±1.9999mA	reading ±	0.1μA	1K	
2780A-10	±19.999mA	0.005% of	1μA	100 Ohm	1 watt Dissipation
2780A-11	±199.99mA	Range	10μA	10 Ohm	
2780A-12	±1.9999A		100μA	1 Ohm	

TEMPERATURE COEFFICIENT:

Zero	0.0005% of full scale/°C
Reading	0.002% of reading/°C
Divider and Shunt Temperature Coefficient (All models except 2780A-02)	0.00125% of reading/°C
Response Time	850msec to 99.99% of DC step change
Noise Rejection	Common Mode: 100dB @ DC >80dB @ 50/60 Hz Maximum common mode voltage = 500VDC or peak AC Normal mode: 40dB @ 50/60Hz
Sample Rate	3 per second nominal
Input Bias Current	100 picoamps nominal*
Overrange Indication	Display flashes approximately 3 times/second

*Stated at 23°C ± 3°C @ less than 85% R.H.

Continuous Sample	Normal operation, no jumpers required
Single Sample	Single sample can be obtained by holding single sample input on rear connector at logic 0 (ground) and applying logic 1(+3.5V to 5.5 V) to Sample Inhibit for 1 to 200msec.
BCD Output ("E" & "N" Option)	Parallel 8-4-2-1 BCD for all digits, TTL Compatible Logic

"E" Option	"N" Option
Logic 1 = +2.4V min. @ 100μA Source Logic 0 = +0.4V max. @ 1.6mA Sink	Logic 1 = +2.4V min. @ 0.4mA Source Logic 0 = +0.4V max. @1.6mA Sink

Reading Retention	TTL Logic 1 retains last BCD reading. An open circuit will provide normal operation. Overrange produces 20K Bit High
Enable ("E" Option only)	TTL logic "1" or open enables all BCD output lines. TTL logic "0" causes all BCD output lines to assume a third high impedance state.
Operating Ambient	+50°F to + 122°F +10°C to +50°C
Power Requirements	105/125V or 210/250V, 50/400Hz, 4VA Option "R" only: 5 volts ± 5%, 500 milliamps
Dimensions	4.39"W x 1.89"H x 4.50"D 11.15 cm W x 4.8 cm H x 11.43 cm D
Mounting Hole	3.75" x 1.72" 9.53 cm x 4.37 cm
Weight	Net: 1 lb. Shipping: 1½ lbs. 0.45 kg 0.675 kg.
Power/Analog Connector	Cinch 50-30A-30 (use P/N 51-07548-15)
BCD Connector ("N" Option only)	Cinch 50-24A-30 (use P/N 51-07548-12)

1.5 Precautions

The input and BCD connectors are keyed with the pin numbers on top and the connector for the Alarm Option, (Option C) is keyed with the letter "B" on top. Failure to mount the connector correctly may result in permanent damage to the instrument. To operate these instruments, earth ground as well as high and low power MUST be supplied to the connector. Unstable readings may occur if the earth ground connection is deleted.

Do not apply AC power to units with a model number containing the suffix R.

The Model 2780A incorporates two (2) fuses for increased instrument protection. A currenting limiting fuse, F2, guards against major fault conditions (large overload); and a thermal fuse, F1, protects the instrument should a minor fault condition occur (temperature above a safe level causes thermal fuse to open).

Both the fuses are "one-time" devices which must be replaced once they have opened. Part numbers for these fuses are given in the MAIN BOARD parts list in Section 6 of this manual. Their physical locations are illustrated in Figure 15.

2. OPERATION

2.1 Power Connections

All instruments have a lower connector J1 used for line power and analog input connections. Instruments which have BCD output ("N" or "E" option) have a second connector J2 located directly above J1 for interfacing with peripheral equipment (See Figure 1).

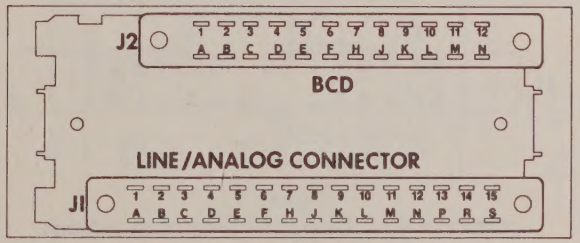


Figure 1
Rear View of Instrument

WARNING

Power input is applied to the rear connector J1, on Pins 5 and 7 with power line ground at Pin D. Failure to use power line ground according to latest electrical code may result in a SHOCK HAZARD or unstable readings. Power connections must be properly insulated before applying power.

Figures 2, 3, and 4 indicate the proper connection for 115 and 230 volts AC and +5 volts DC operation.

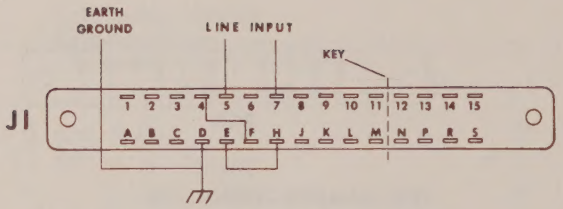


Figure 2
105/125 VAC Operation Input Connections

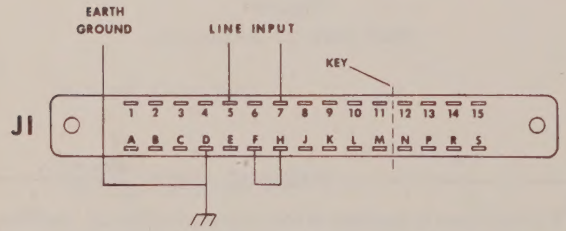


Figure 3
210/230 VAC Operation Input Connections

CAUTION

Do NOT apply AC power to units with a model number containing the suffix "R".

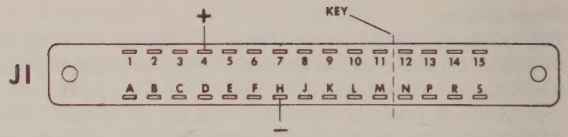


Figure 4
5 Volt DC Operation Input Connections (R Option Only)

2.2 Signal Input Connections

Instrument may be either a voltmeter or an ammeter by proper connection of external resistors on the line and analog connector J1. Additional features such as decimal point positions, and reading retention will be discussed in their respective sections.

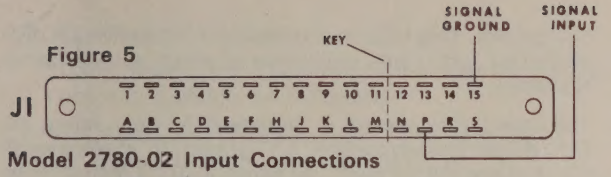
WARNING

These instruments are designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD on inside front cover.

Input terminations must be insulated before applying an input signal. For maximum safety turn off all power to the circuit being measured, before connecting or disconnecting leads.

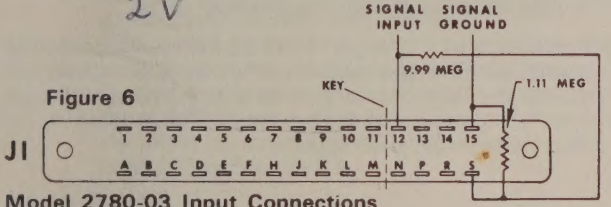
Figures 5 through 9 illustrate the various input connections.

Figure 5



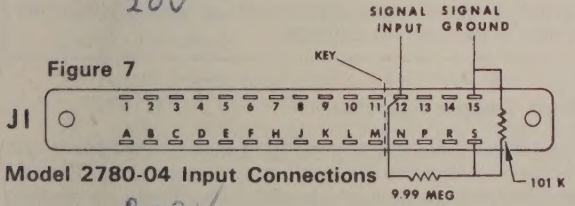
Model 2780-02 Input Connections

Figure 6



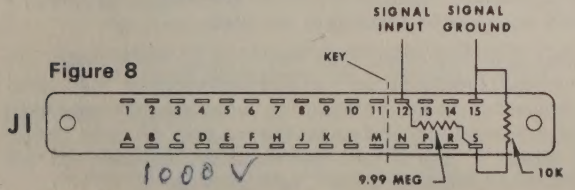
Model 2780-03 Input Connections

Figure 7



Model 2780-04 Input Connections

Figure 8



Model 2780-05 Input Connections

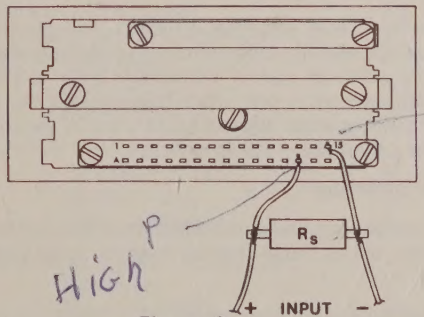


Figure 9

2.3 Decimal Point Location

The decimal point may be located in any one of four positions as determined by jumpers on the rear connector (J1).

The chart below indicates the proper jumper location on the rear connector, J1, for each specific decimal point. (Floating decimal point may be obtained by external switching).

Location	Jumper
000.0	J to K
00.00	J to L
0.000	J to 9
.0000	J to 10
0000	NONE

2.4 Front Panel Offset Adjust

The Model 2780A employs a CMOS, LSI circuit design which automatically maintains an extremely stable zero point. To optimize use of this stable zero, a front panel offset adjustment is provided. This permits the operator to null out low-level signals generated in external input leads or peripheral instrumentation.

2.5 System Interface

There are two requirements which must be met for proper operation using these instruments in a data recording system.

1) A method of preventing the BCD data from changing while recording is in process.
2) A method of indicating to the recording device that BCD data is stable and ready to be recorded.

With both the BCD "E" option and "N" option (see Section 2.10), READING RETENTION will allow the instrument to continue sampling while inhibiting BCD from updating, thus preventing the BCD from changing while data is being recorded. To inhibit the BCD, apply logic "1" to READING RETENTION (J, Pin N), during the entire recording cycle.

At the end of a measuring cycle, the POSITIVE TRUE BUSY signal switches from logic "1" to logic "0" indicating data is stable and ready to be recorded.

In addition to the above requirements for transmitting data, the BCD "E" option provides a special ENABLE feature. Single line enable permits numerous 2780A Digital Panel Meters to continuously monitor any number of data sources and record the measured data using only one printer. This feature provides a constant visual display of all data points regardless of which point is being recorded.

This interfacing system is employed by connecting all BCD output lines in parallel. A TTL logic "0" applied to J2 Pin H of each instrument will cause all BCD output lines to assume a "third, high-impedence" state.

Application of TTL logic "1" to J2 Pin H of a particular instrument (selected remotely or by manual switches) will enable the BCD output lines of that instrument. Those lines will then provide the proper BCD data (logic "1" or "0") for the monitored input.

CAUTION

Enabling two or more instruments simultaneously may result in permanent damage.

2.6 Single Sample Operation

The normal sampling operation of these instruments can be modified to allow the instrument to sample-and-hold a specific input voltage or current, thus allowing a reading to be produced only on command. The digital display and BCD output (if applicable) will be retained indefinitely or until an updated reading is required.

When $\overline{\text{SAMPLE}}$ $\overline{\text{INHIBIT}}$, J1, Pin 11 or J2, Pin A, (logic "1" or open) is removed for 1 to 200 milliseconds, the instrument will complete a measuring cycle (maximum delay of 330 milliseconds) and retain the reading. An open circuit or logic "1" signal for more than 200 milliseconds will provide multiple or continous sampling.

2.7 Check Out Procedure

Upon receipt of the instrument, the following check out procedure should be followed:

1) Apply power (see Section 2.1 for details).
2) Allow thirty (30) minutes warm up.
3) Connect a jumper between signal input and signal ground (see Section 2.2 for details)
4) Remove the jumper and apply an appropriate voltage or current to the input (see Section 2.2 for details).
5) Display should equal input voltage or current within the specifications outlined in Section 1.4. If unit does not meet specifications, recalibration may be required. See Section 2.8.

2.8 Calibration

To calibrate the instrument, the following procedure should be used:

1) Apply power (see Section 2.1) and warm up for at least thirty (30) minutes.
2) Apply a voltage or current to the input terminals equal to a display of 19000 (see Section 2.2). Either polarity may be used.
3) Locate the calibration adjustment screw (R6, see Figure 15) on the printed circuit board by looking through the slots in the case on the left hand side of the instrument. Do not remove the case.
4) Insert a small screwdriver through the slot and adjust the calibration screw for a display of 19000.

2.9 Rear Connector

The following table defines the various functions on rear connector J1 and the pins on which they are located.

FUNCTION	PIN NO.
Power (All Models)	4,5,7,E,F,H
Power ("R" Option Only)	
+5V (high)	4
+5V (low)	H
Earth Ground	D
INPUT SIGNAL	
Standard Input	P
Divider Input	S
Signal Ground	15
DECIMAL POINT POSITION	
Common	J
Position .0000	10
Position 0.000	9
Position 00.00	L
Position 000.0	K
$\overline{\text{SAMPLE}}$ $\overline{\text{INHIBIT}}$	11
Polarity	2
Ground	15
+5 Volt Logic Level (50 mA Max)	8
Supply Com.	B
FACTORY TEST VOLTAGES (Do not use these voltages for external circuitry)	
+12V	A
−12V	1
+6.2V	13
Not Connected	3,6,12,14,C,M,N

2.10 BCD Output Connector J2, ("E" & "N" Options Only)

Instruments containing and "E" or "N" suffix to the model number have positive true, TTL compatible BCD output.

Logic Levels for "E" option are:

Logic 1 = +2.4V Min @ 100μA Source
Logic 0 = +0.4V Max @ 1.6 mA Sink

Logic Levels for "N" option are:

Logic 1 = +2.4V Min @ 0.4 mA Source
Logic 0 = 0.4V Max @ 1.6 mA Sink

Functions and pin numbers are given below:

FUNCTION	PIN
BCD 1	B
BCD 2	D
BCD 4	4
BCD 8	C
BCD 10	3
BCD 20	E
BCD 40	6
BCD 80	5
BCD 100	F
BCD 200	K
BCD 400	10
BCD 800	9
BCD 1000	L
BCD 2000	12
BCD 4000	M
BCD 8000	8
BCD 10,000	7
Polarity Bit	11
BCD Ground	2

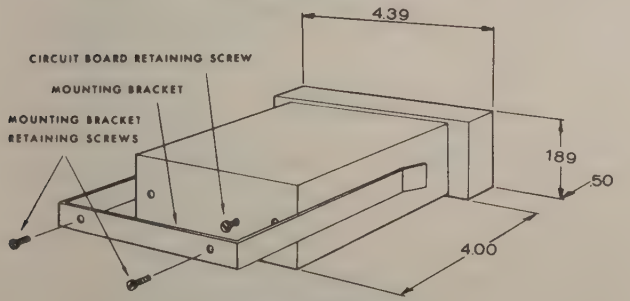
SYSTEM INTERFACE	E Option	N Option
Reading Retention	N	N
BCD 20,000 Overrange Indication	A[1]	A[2]
Sample Inhibit	A[1]	A[2]
Enable	H	—
Busy	1	1
+5V	J	J

1. When shipped from the factory, $\overline{\text{Sample Inhibit}}$ is assigned to Pin A of the "E" Option Board. For a BCD 20K overrange indication, simply relocate a jumper as indicated in Figure 18.

2. When shipped from the factory, the "N" Option Board has the SAMPLE INHIBIT assigned to Pin A. For applications where a 20K overrange indication is required instead of $\overline{\text{SAMPLE INHIBIT}}$, simply relocate a jumper (R5) as indicated in Figure 19. When the jumper has been repositioned, a 20K overrange indication will be available on Pin A.

3. INSTALLATION

These panel meters are designed to install into a 3.75" x 1.72" hole. To install, remove the two mounting bracket retaining screws and the mounting bracket. Slide the instrument in from the front an reinstall the mounting bracket and retaining screws (see Figure 10).



Outline Drawing
Figure 10

4. CIRCUIT DESCRIPTION

Analog to digital conversion is accomplished by using an analog (see Figure 11) and a digital processor (see Figure 12).

The analog processor consists of an integrator, a comparator, an auto zero circuit and a pulse width modulated reference current.

The input (measured signal "M") is applied, through a buffer, to an integrator. The output of the integrator is then compared to the output of an auto-zero buffer. If the output of the comparator is above zero, the input of the integrator will be driven down (D) by applying Vref to the input of the integrator for 15 clock pulses and Ground for one clock pulse. If the input of the comparator is below zero, the input of the integrator will be driven up by applying Ground for 15 clock pulses and Vref (D) for 1 clock pulse.

This continues for 32,768 clock pulses. At this time the input buffer is switched from the input signal (M) to the zero reference (Z) and a charge is placed on C3 to automatically compensate for any drift in the measuring circuit.

At the same time the Up/On counter has the difference between the Vref clock pulse and the Ground clock pulses in its registers. The difference being a BCD representation of the analog input (M).

The BCD is decoded with a BCD to 7 segment decoder and strobed one digit at a time into the LED displays.

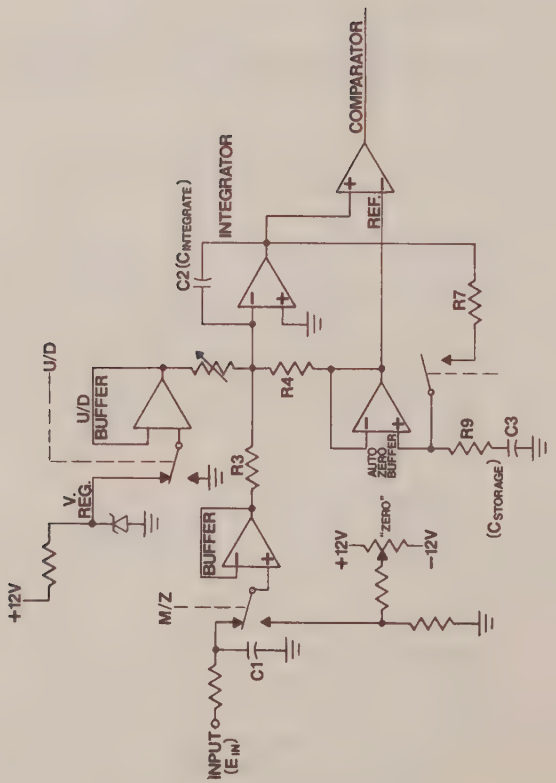


Figure 11
Block Diagram, A/D Section

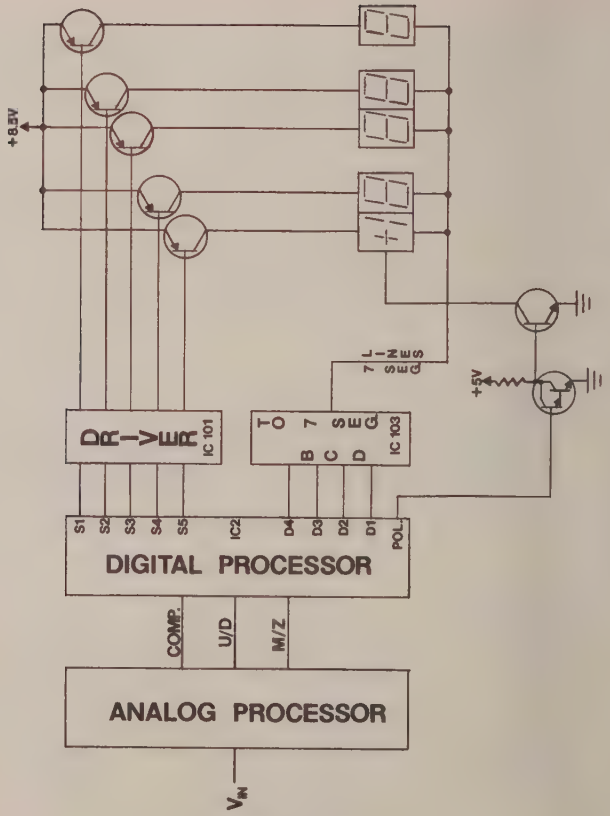


Figure 12
Block Diagram, Digital Section

5. MAINTENANCE

If the instrument operates, but is inaccurate, calibrate before troubleshooting (see Section 2.8).

5.1 Disassembly

WARNING

Remove all power and input signal before removing the rear connectors.

To disassemble the instrument from the case, remove the mounting bracket retaining screws, mounting bracket, and the circuit board retaining screw. Hold the instrument with both hands and use your thumbs to push on the edge connector portion of the circuit boards that extend from the rear of the case until the edge of the board is flush with the case. The internal circuit board assembly can now be gently pulled from the front of the case. The display window, which will remain attached to the display board, can be taken off by removing two (2) window retaining screws from the rear of the display board.

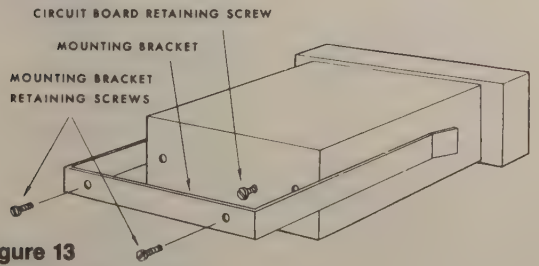


Figure 13
Assembly Drawing

5.2 Inspection

Thoroughly inspect the instrument for any obvious faults. Often, before a total or partial failure occurs, a deteriorating component can easily be observed due to obvious discoloration, cracking or warping. Inspect the instrument to detect loose, broken or frayed wiring, dirty or pitted switch and connector contacts, and cracked or broken printed circuit boards. Determine that all controls, connectors, and mechanical hardware are properly and securely mounted.

WARNING

Exposed connectors, electrical terminals and components within the instrument may be connected to dangerous voltage potentials. Exercise due caution when performing internal inspections, adjustments or repairs. To avoid potential shock hazards, disconnect all power.

5.3 Troubleshooting

If the instrument operates, but is inaccurate, calibrate before troubleshooting (See Section 2.8). If the operation of the instrument cannot be corrected by calibration, corrective maintenance may be required.

The most important aspect of isolating faults is the formulation of a logical approach to locating malfunctions based upon knowledge of the theory of operation described in Section 4. Full use of operating instructions, block diagrams and schematics will be useful in isolating faults. For location of components listed in the following table, see Figure 15.

TROUBLESHOOTING CHART

SYMPTOM	Possible Cause/Correction Procedure
1) Display not illuminated	Defective fuse (f1, f2) or IC5. Check power supply (instrument does not have to be removed from its case). With Pin B of J1 as reference, check for +5 Volts (±.3V) at Pin 8; +12 Volts (±.7V) at Pin A; and −12 Volts (±.7V) at Pin 1. If +12 Volts and −12 Volts are measured but +5 Volts is missing, replace IC5. If all three voltages are missing, check fuses f1 and f2. Cause of failure should be determined before replacing a defective fuse (i. e. shorted transformer or capacitor - C14, C15, C16).
2) Only one digit illuminated or one digit brighter than normal	Defective IC2 or Q2. With oscilloscope, check oscillator operation at emitter of Q2. If oscillations are present at a frequency of 164 kHz (±10 kHz), replace IC2. If oscillations are not present, replace Q2.
3) One segment of a digit either missing or continuously illuminated.	Defective IC102 or IC103. Replace faculty component.
4) One digit not illuminated	Defective IC2, IC101 or one of transistors Q101 thru Q105. Replace faculty component.

5) One or more segments of an LED will not illuminate.	Defective LED. Replace. The LED's in this instrument are matched for consistent brightness. When replacing an LED, care should be taken to replace it with an LED of the same brightness grade (LED's are matched by a Letter code located on the side of the component. LED's used most frequently are coded E, F, or G).
6) Unit will not adjust to full scale calibration.	Defective IC1 or D2. Check reference voltage at Pin 13 of J1 for +6.2V (±.4V). If voltage is correct, replace IC1. If voltage is not correct replace D2.
7) Unit will not zero.	Defective IC1 or D1. Replace faulty component.

6. REPLACEMENT PARTS

Replacement parts for the components shown on schematics and component location drawings are listed in alpha-numerical order by reference designator under their respective assemblies. It is recommended that replacement parts be purchased directly from United Systems Corporation or one of its authorized service centers. The minimum charge is $25.00 on all orders.

For each replacement part the following information should be included:

Instrument Model Number
Instrument Serial Number
Part Reference Designator
Part Description
Part Stock Number

MAIN BOARD
(Logic and Power Supply)

Ref. Des.	Description	USC Stock Number
C1	Capacitor, .1μF @ 250V	56-16873-104H2R5
C2	Capacitor, 1500pF @ 250V	56-16873-152H2R5
C3	Capacitor, 1μF @ 35V	56-12731B105N35
C4,5	Capacitor, 2.2μF @16V	56-12731A225N16
C8	Capacitor, .01μF @ 250V	56-16873103H2R5
C9	Capacitor, 2700pF @ 500V	56-1021OB272FK5
C10, 17, 18	Capacitor, 10μF @ 16V	56-12731E106N16
C12, 13	Capacitor, .02μF @ 100V	56-10215N203KP1
C14, 15	Capacitor, 100μF @ 25V	56-10203-107N25
C16	Capacitor, 2200μF @ 10V	56-13217L228N10
C19	Capacitor, 500pF @ 1000V	56-10215F501JC10
D1	Diode, dual (E7062)	40-16800
D2	Diode, 1N827A	40-12364
D5	Diode, rectifier (MDA100A)	40-17557-01
D9, 10	Diode, 1N4001	40-07787-01
F1	Fuse, thermal	52-16830-096
F2	Fuse	52-17936-05
IC1	I. C., converter (LD120)	40-17534
IC2	I. C., converter (LD121)	40-17535
IC3	I. C., regulator (78L12AC)	40-15325
IC4	I. C., regulator (79L12CP)	40-16798
IC5	I. C., regulator (78M05C)	40-16501
L1	Inductor, (360μH)	42-17563AH361
Q1	Transistor, 2N5172	40-11353
Q2	Transistor, MPS4355	40-16253
R1	Resistor, 92.10K, ⅛W, .1%	55-10168BGK092R1
R2	Resistor, 100K, ⅛W, .1%	55-10168BGK100

R3	Resistor, 121K, ⅛W, 1%	55-10168ELK121
R4	Resistor, 10K, ¼W, 5%	55-10101HK010
R5, 40	Resistor, 4.7K, ¼W, 5%	55-10101HK004R7
R6	Potentiometer, 5K	41-11611-09
R7	Resistor, 1M, ¼W, 5%	55-10101HM001
R8	Resistor, 47.5 ohm, ⅛W, 1%	55-10168ELA047R5
R9	Resistor, 392 ohm, ⅛W, 1%	55-10168ELK392
R10, RB00	Resistor, 10 ohm, ¼W, 5%	55-10101HA010
R11	Resistor, 825 ohm, ¼W, 5%	55-10168ELA825
R19	Resistor, 27.4 ohm, ⅛W, 1%	55-10168ELA027R4
R20	Resistor, 22K, ¼W, 5%	55-10101HK022
R21	Resistor, 82 ohm, ¼W, 5%	55-10101HA082
R22, 35	Resistor, 2.2K, ¼W, 5%	55-10101HK002R2
T1	Transformer, power	42-16928
Complete Board Assembly		05-17555

EXTERNAL VOLTAGE RANGE RESISTORS

Model 2780A-02	None Required	
Model 2780A-03		
R36	Resistor, 9.99M, 1W, .1%	55-10165BJM009R99
R37	Resistor, 1.11M, ½W, .1%	55-10111BJM001R11
Model 2780A-04		
R36	Resistor, 9.99M, 1W, .1%	55-10165BJM009R99
R37	Resistor, 101K, ½W, .1%	55-10111BJK101
Model 2780A-05		
R36	Resistor, 9.99M, 1W, .1%	55-10165BJM009R99
R37	Resistor, 10K, ½W, .1%	55-10111BJK010
Model 2780A-08		
R36	Resistor, 10K, ½W, .1%	55-10111BJK010

Model 2780A-09 R36	Resistor, 1K, 1W, .1%	55-10121BDK001
Model 2780A-10 R36	Resistor, 100 ohm, 1W, .1%	55-10121BDA100
Model 2780A-11 R36	Resistor, 10 ohm, 1W, .1%	55-10121BDA010
Model 2780A-12 R36	Resistor, 1 ohm, 25W, .1%	55-10130BFA001
	DISPLAY BOARD	
IC101	I. C., Driver (75492)	40-15962
IC102	I. C., (MC1413CP)	40-17556
IC103	I. C., Decoder (14511)	40-16799
LED 101	LED Display, MAN6630GB	40-17705
LED 102	LED Display, MAN6610GB	40-17706
LED 103	LED Display, MAN6660GB	40-17704
Q1-5	Transistor, MPS4355	40-16253
Q6	Transistor, 2N5306	40-09277
Q7	Transistor, 2N5172	40-11353
R101	Resistor, 360 ohm, ¼W, 5%	55-10101HA360
R102, 113	Resistor, 47K, ¼W, 5%	55-10101HK047
R103	Resistor, 39 ohm, ¼W, 5%	55-10101HA039
R104	Resistor, 56 ohm, ¼W, 5%	55-10101HA056
R105-111	Resistor, 68 ohm, ¼W, 5%	55-10101HA068
R112	Resistor, 100K, ¼W, 5%	55-10101HK100
R114	Resistor, Potentiometer 250K	41-16821-KLK250
R115	Resistor, 10 ohm, ¼W, 5%	55-10101HA010
	Complete Board Assembly	05-17702

BCD BOARD ("N" OPTION)

Ref. Des.	Description	USC Stock Number
C1	Capacitor, .001μF @ 1000V	56-10215B102KT10
C2	Capacitor, .01μF @ 50V	56-10215B103KYR5
C3	Capacitor, .056μF @ 250V	56-15617J563J2R5
C4	Capacitor, 10μF @ 10V	56-12731C106N10
ICl-5	I.C. (93L14)	40-14289
IC6	I.C. (MC-14050)	40-16839
IC7 & 8	I.C. (MC-14011B)	40-15957
IC9	I.C. (9L24)	40-14286
R1, 3, 4	Resistor, 10K, ¼W, 5%	55-10101HK010
R2	Resistor, 100K, ¼W, 5%	55-10101HK100
R5	Resistor, 2.2K, ¼W, 5%	55-10101HK002R2
	Complete Board Assembly	05-18303

BCD BOARD ("E" Option)

Ref. Des.	Description	USC Stock Number
C1, 2	Capacitor, 0.001μF @ 1000V	56-10215B102JC10
C3	Capacitor, 10μF, @ 6.3V	56-12731B106N06R3
IC1	Integrated Circuit, MC 14013	40-16840
IC2-6	Integrated Circuit, MC 14076	40-18005
IC7-10	Integrated Circuit, MC 14503	40-16622
R1,6	Resistor, 2.2K, ¼W, 5%	55-10101HK002R2
R2, 4, 7, 9	Resistor, 10K, ¼W, 5%	55-10101HK010
R3,5	Resistor, 100K, ¼W, 5%	55-10101HK100
R8	Resistor, 47K, ¼W, 5%	55-10101HK047
R10	Resistor, 1K, ¼W, 5%	55-10101HK001
	Complete Board Assembly	05-18007

MISCELLANEOUS HARDWARE

Description	USC Stock Number
Case (White)	30-16237-01
Connector, line/analog input	51-07548-15
Connector, BCD ("E" and "N" Option)	51-07548-12
Connector Key	51-11797
Window, Front Panel	30-16327
Window Mask	39-17711
Anti-Static Strip	51-16929-02R5

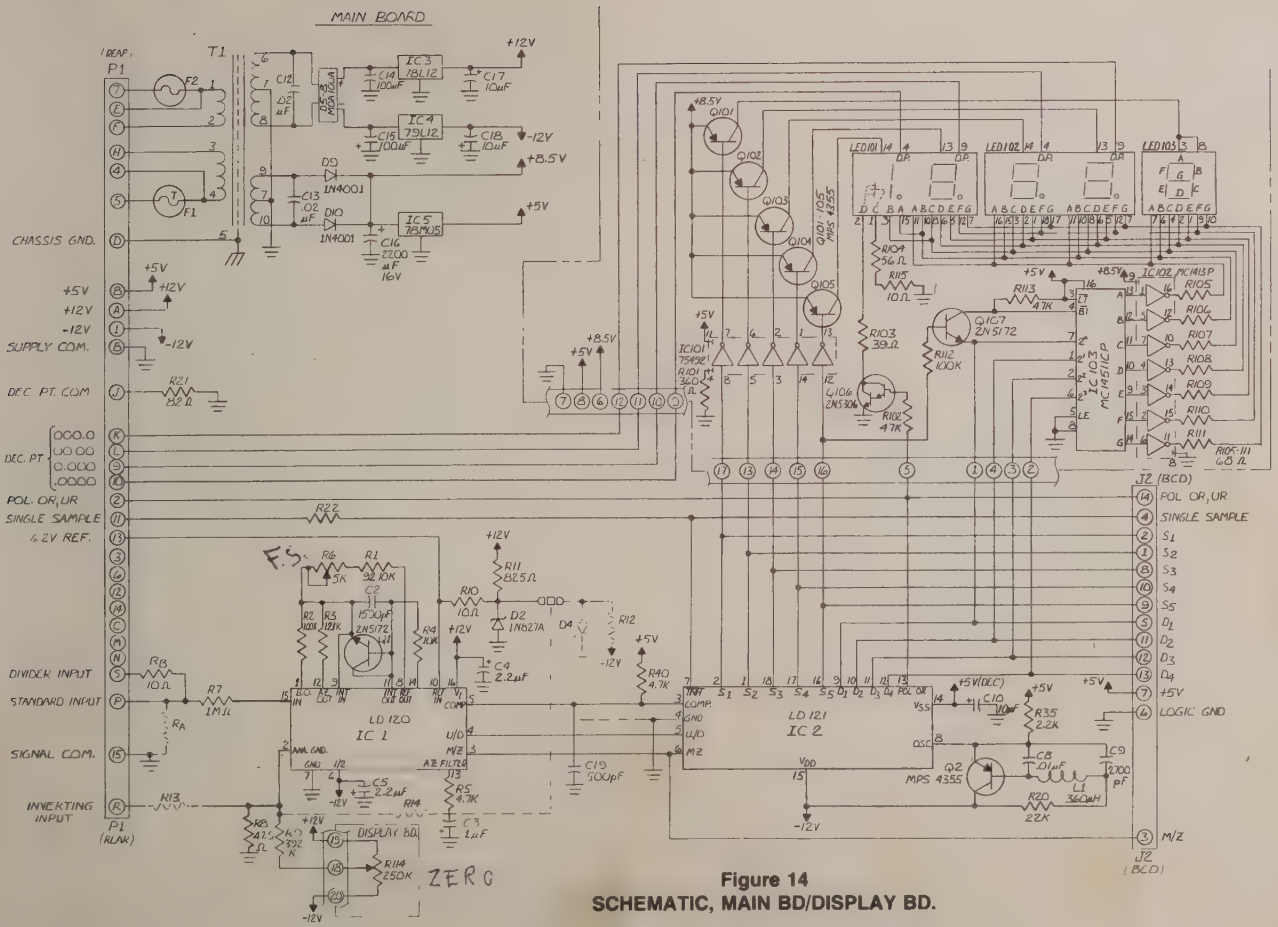
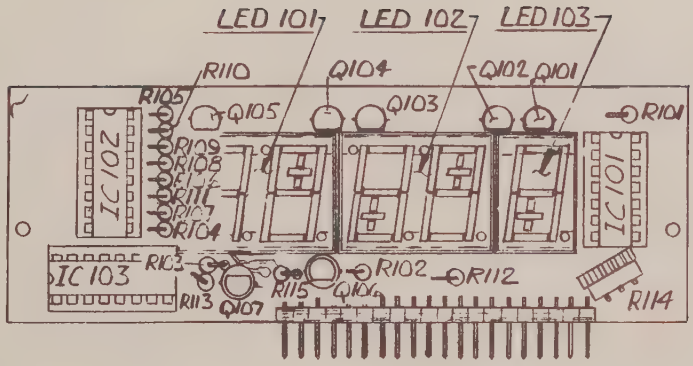


Figure 14
SCHEMATIC, MAIN BD/DISPLAY BD.



COMPONENT LOCATION, DISPLAY BD.

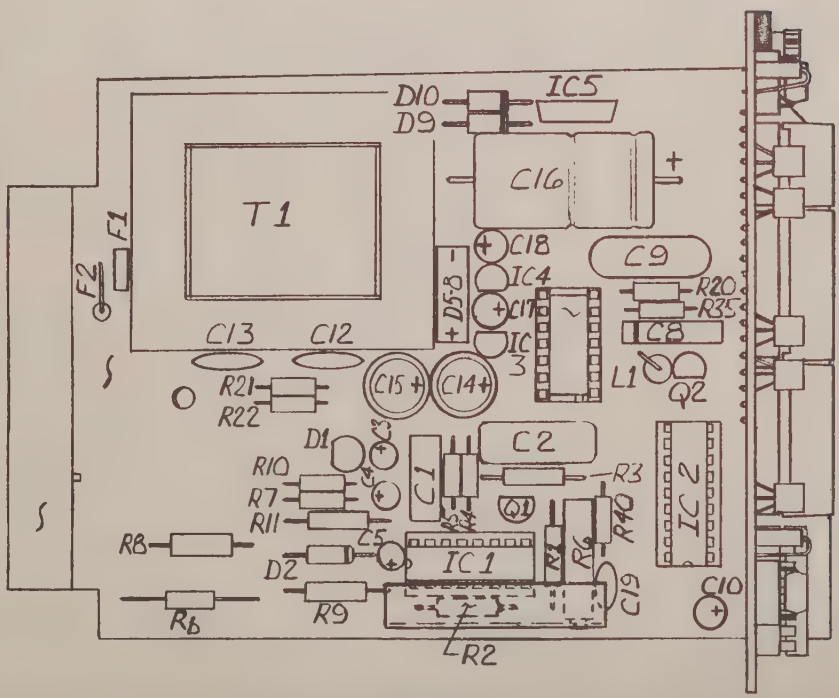


Figure 15
COMPONENT LOCATION, MAIN BD.

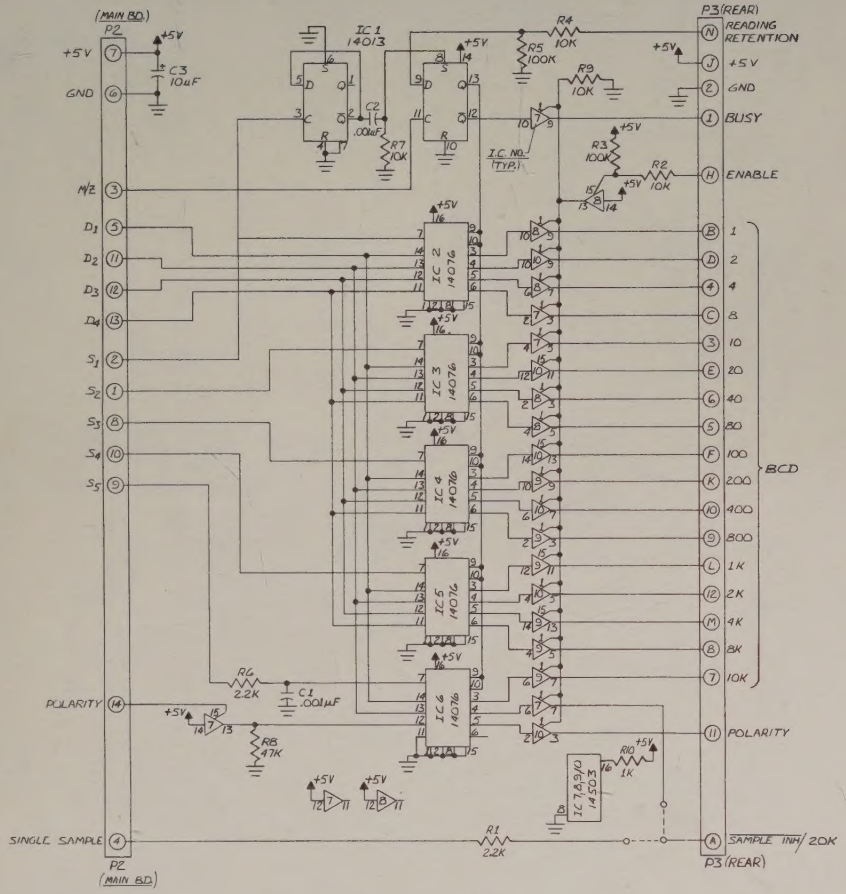


Figure 16
SCHEMATIC, "E" OPTION BCD BD.

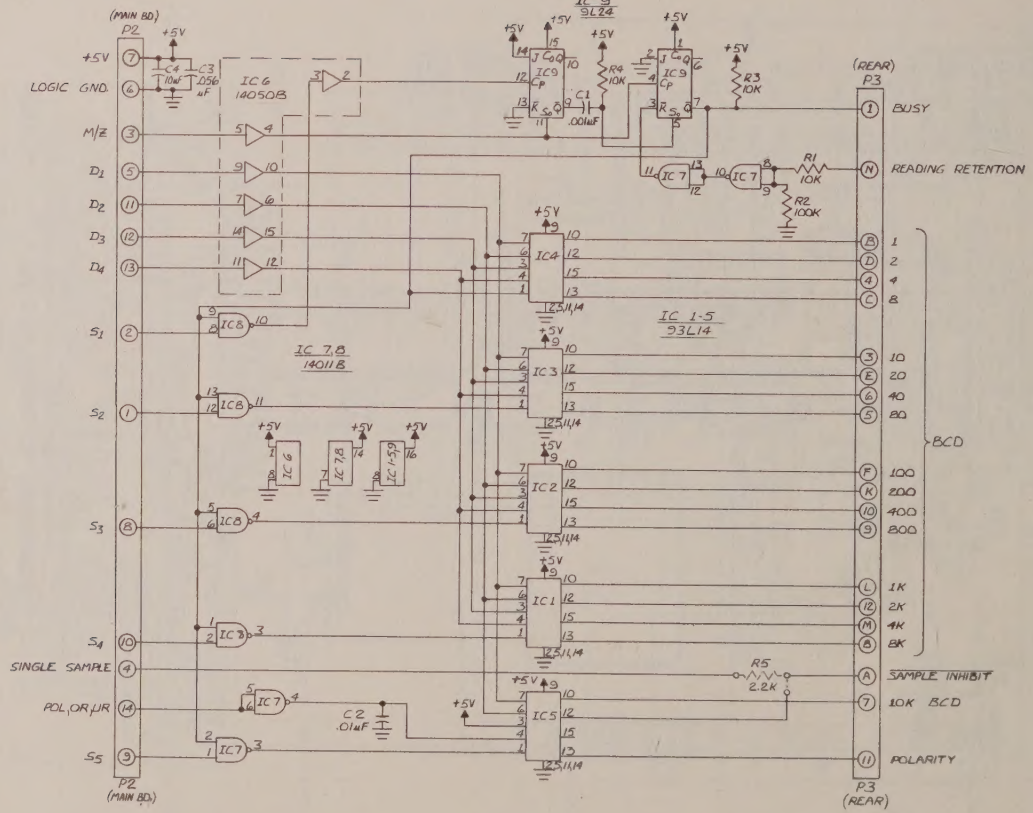


Figure 17
SCHEMATIC, "N" OPTION BCD BD.

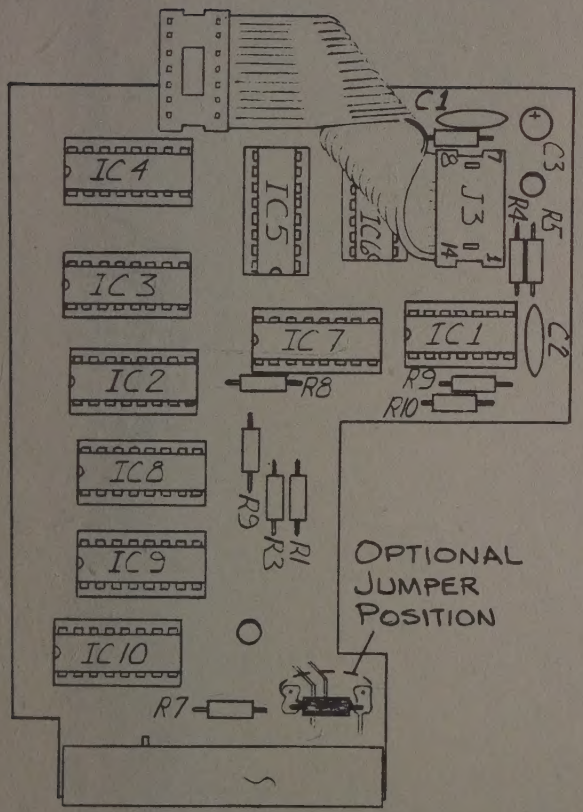


Figure 18
COMPONENT LOCATION "E" OPTION BCD BD.

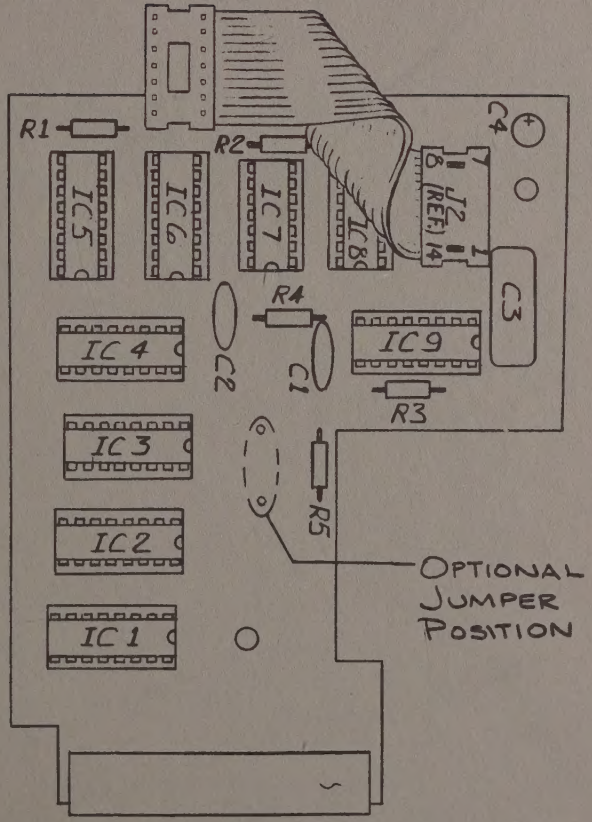


Figure 19
COMPONENT LOCATION, "N" OPTION BCD BD.

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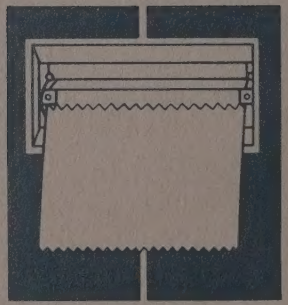

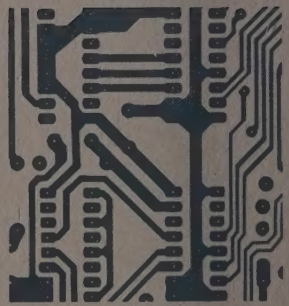

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